

# **MOON IMPACT!**

## **Lesson Plan for Gifted and Talented Learners**

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### **NASA SOLAR SYSTEM AMBASSADOR MASTER TEACHER, TN**

#### **Rationale**

##### **The primary learning outcomes:**

- The learner will be able to increase their understanding of and comfort with the nature of science and the scientific process through the context of an interesting real-world scientific interactive hands-on lesson.
- The learner will examine asteroids and meteors as they impact the moon/Earth.

The teacher will share with the students a power-point lesson/hand-out on Moon Impact/asteroids and meteors . Following the power-point demonstration, students will extract meteors from “the Moon” and measure the depth/width of the craters left behind.

##### **Background:**

- Asteroids are rocky and metallic objects that orbit the Sun, but are too small to be considered planets. They are also known as minor planets and have diameters up to about 1000 km. Meteors are better known as "shooting stars": startling streaks of light that suddenly appear in the sky when a dust particle from outer space evaporates high in the Earth's atmosphere. We call the light phenomenon in the atmosphere a "meteor", while the dust particle is called a "meteorite".
- That tiny particle can cause a light so bright that it can be seen over distances of hundreds of kilometers. The reason is the astronomical speed of the meteoroids. Just before they enter the Earth's atmosphere, Leonid meteoroids travel at 71 kilometers per second, or some 2,663 times as fast as a fast pitch in baseball, or, if you want, around the Earth in 3.8 minutes!

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#### **Objective**

##### **The students will:**

- learn about the effects of cosmic impacts on the moon and Earth

#### **MATERIALS:**

*Based on a group size of 2-3 students:*

- 9" x 18" baking pan (one per group)
- Sand or flour (5 pounds per group)
- Marbles, various sizes (3 per group)
- Bearings, various sizes (3 per group)
- Small stones, various sizes (3 per group)
- Toothpicks (12 per group)

- Marker (one per group)
- Disposable gloves (1 per group)
- Plastic spoons (1 per group)
- Cleanup cloths (1 per group)
- Broom (1 per class)
- Dustpan (1 per class)
- Metric ruler (1 per group)
- Small plastic sandwich bags (3 per group)

## **National Science Standards**

### **National Academy of Sciences:**

The National Science Education Standards provide guidelines for teaching science as well as a coherent vision of what it means to be scientifically literate for students in grades K-12.

This lesson plan may be used to address the academic standards listed below. These National Science Education Standards are drawn from Content Knowledge for Understanding Scientific Inquiry. The science subject matter focuses on the science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use

This lesson plan addresses the following National Science Education Standards-National Research Council:

- Evidence, models and explanation
- Change, constancy, and measurement
- Abilities necessary to do scientific inquiry
- Properties of objects and materials
- Understanding about science and technology

This lesson plan addresses the following Principles and Standards for School Mathematics/Pre K - 12 -National Council of Teachers of Mathematics

- Number and Operations
- Measurement
- Data Analysis and Probability
- Problem Solving
- Reasoning and Proof
- Communication
- Connections
- Representations

### **Pre-Assessment:**

- Originality, Flexibility, Fluency brainstorming
- Metacognition (Students thinking about thinking/brainstorming about the Moon!) Students will begin by brainstorming in small groups **Who, What, When, Where, How and Why**, questions that they would like to discover/have answered about the Moon. Students will post their questions on post-it notes/parking lot.
- Students will brainstorm in small groups the question, Which one of these pictures you think is an asteroid and why?

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#### ***Instructor Guide***

#### ***Grade Two, Week 1 Supplemental Mission***

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### **Project Impact**

#### **Mission Role:**

Meteor Impact Specialists

#### **Estimated Time of Mission:**

30 - 45 minutes

### **ANTICIPATORY SET:**

### **PROCEDURE**

#### **Mission Background:**

Asteroids are rocky and metallic objects that orbit the Sun, but are too small to be considered planets. They are also known as minor planets and have diameters up to about 1000 km. Meteors are better known as "shooting stars": startling streaks of light that suddenly appear in the sky when a dust particle from outer space evaporates high in the Earth's atmosphere. We call the light phenomenon in the atmosphere a "meteor", while the dust particle is called a "meteorite". That tiny particle can cause a light so bright that it can be seen over distances of hundreds of kilometers. The reason is the astronomical speed of the meteoroids. Just before they enter the Earth's atmosphere, Leonid meteoroids travel at 71 kilometers per second, or some 2,663 times as fast as a fast pitch in baseball, or, if you want, around the Earth in 3.8 minutes! When meteoroids enter the Earth's atmosphere, they collide with numerous air molecules. Those collisions sputter away the outer layers of the particle. In this process, electrons are stripped off the individual atoms. When the atoms recapture these electrons, light is emitted. This is the same process as in gas discharge lamps. The color of many Leonids is like the color of our sodium discharge lamps. For the same reason: meteoroids contain traces of sodium. The color of a meteor is an indication of its composition and the excitation temperature: sodium atoms give an orange-yellow light, iron atoms a yellow light, magnesium a blue-green light, calcium atoms may add a violet hue and silicon atoms give a red light.

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#### ***Week 1 Supplemental Mission***

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Meteors do not normally cause audible sounds. Hence, they will pass by unnoticed if not seen. But watch out for hissing sounds that have been reported for very bright meteors. These sounds are thought to be due to low frequency radio waves interacting with the local environment. A sonic boom is sometimes heard for very bright meteors, the fireballs. If the particle is larger than the mean free path of the air molecules, a high Mach number shock wave forms in front of the meteoroid. Very rarely, this shock wave penetrates deep enough in the atmosphere that it can be heard. It sounds like the sonic boom of an airplane, but as a distant rumble. Comets are mountains of ice and dust. When comets approach the Sun, the ices evaporate and the dust particles are ejected into orbit in geyser like fountains.

Only when the Earth travels through relatively fresh cometary matter will rates go up significantly above the normal level of annual activity. Then, and only then, can we see a meteor outburst. The Leonid storms are such meteor outbursts. There were no Leonid outbursts reported between 1970 and 1993. The first Leonid outburst of a new series associated with the upcoming return of P/Tempel-Tuttle was seen in 1994. Not long ago, many people thought that comets were a sign that something bad was about to happen to them. Long ago people didn't understand about how objects in the sky moved, so the sight of a comet must have been very disturbing. There are many historical records and works of art which record the appearance of comets and link them with terrible events such as wars or plagues. Now we know that comets are lumps of ice and rock that periodically come into the center of the solar system from somewhere in its outer reaches, and that some comets make repeated trips. When comets get close enough to the Sun, heat makes them start to evaporate. Jets of gas and dust form long tails that we can see from Earth. These tails can sometimes be millions of miles long. In 1985-1986, a spacecraft called Giotto visited the most famous comet, Halley, on Halley's most recent visit to the inner solar system. In 1993, comet Shoemaker-Levy became trapped by the gravity of Jupiter and plunged into Jupiter's atmosphere! In 1996 and 1997 we saw comet Hyakutake, and comet Hale-Bopp. Hale-Bopp was one of the brightest comets ever seen on Earth.

### **Mission Vocabulary:**

**Asteroids** any of the many small planets that move in orbits around the Sun

**Meteors** any of the many small, solid bodies traveling through outer space

**Meteorites** a mass of metal or stone remaining from a meteor that has fallen upon the Earth

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### **Mission Preparation:**

1. Flour works best for this activity, however it is the messiest. Caution should be shown to keep the flour in the pan and not all over the work area.
2. To conserve gloves, one of the students in the group should wear the pair of gloves and carefully remove the "meteors" from the impact area.
3. Prior to activity, fill each pan 1/3 to 1/2 full with sand or flour.
4. Have water, cloths broom and dustpan ready for "accidents".

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### **Mission Procedures:**

1. Tell the students that they will be training to become Meteor Impact Specialists, that is, they will be able to determine the size and an idea of the shape of the meteor/asteroid/meteorite by the crater it leaves.
2. Demonstrate to the students how to drop the "meteor" into the sand or flour.  
The drop height should be between 12" and 15" above the surface the sand or flour to ensure consistency in all drops. After dropping the meteor, use a toothpick and spoon to carefully scoop meteor into the spoon, trying to leave as much of the impact crater intact. Use gloves if flour is being used to keep from transferring the flour from hands to all the surfaces touched.
3. Take a toothpick and with the tip, touch the bottom of the crater, being carefully not to "poke through" to the bottom of the crater to the pan. With a marker, mark the "top" of the crater, that is, where the crater meets the surface. If ruler is being used, measure (in cm.) the distance of the crater by measuring the toothpick from the tip to the mark as mentioned above. Keep in mind that a second grader may not be able to read a ruler.
4. If the ruler is not being used, have the student place the toothpick and the "meteor" in a plastic sandwich bag.
5. Have students observe the shape of the crater (round, oblong, shallow, deep, thin, wide, etc.)
6. Have the students continue this for each of the "meteors" until all meteors have been dropped and measured. Keep in mind the drop height and to drop the "meteor" in another area of the pan.
7. If more space is needed to drop "meteors", students may, though not suggested, level the surface by shaking the pan a few times.

8. After all the "meteors" have been dropped and measured, compare the depths and shapes of the craters with each other (deep, deeper, deepest, etc.). See if the students can draw a conclusion.
9. Conclusions should be the more mass of the meteor, the deeper the crater. Students won't use the term "mass" but rather size (big, heavier, etc.) Generally, the craters will be bowl shaped and not leave any irregularities of the shape of the meteor; except if it is oblong or oval, then the crater may be oblong or oval in shape.
10. Mention to students that craters are on the moon because of impacts by meteors and meteorites (small meteors). Asteroids are very big meteors and would or could destroy the moon if hit by one. Since the moon has no atmosphere, water or wind, the meteors would not break up nor would the craters they produce be "weathered" or worn by the elements like they are here on Earth.
11. If flour was used with gloves, remove the gloves by taking the ends and peeling" them off and dispose of them.
12. After assessing the groups and drawing a conclusion, the groups may level their craters . . . ideally, this should be done after the students have left the class (during instructor cleanup).

**Mission Debriefing/Assessment:**

Check craters in the pans as the students are performing the activity and see if they can predict what is happening. Students will discuss in small groups/draw conclusions.

**Differentiation:****To Differentiate this Lesson**

- Students will research craters-asteroids and meteors and how they impact the Moon/other planets.

**Assessment:**

- Students will predict what is happening-teacher monitoring
- Students will discuss in small groups/draw conclusions

**References:****Living and Working in Space*****Instructor Guide******Week 1 Supplemental Mission***

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**Mission Resources:**

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Editors of Time-Life Books. *Comets, Asteroids, and Meteorites*. Time-Life, 1992. Generously illustrated.

Livingston, Myra Cohn (1988) *Space Songs*. (Scholastic)

Underwood, Juliette (1995) *GeoTrivia Space*. (Rand McNally for Kids)

Gallant, Roy A., *The Macmillan Book of Astronomy*.

Macmillan/McGraw-Hill

**NASA Exploring Meteorite Mysteries-A Teacher's Guide with Activities for earth and Space Sciences**

**Video**

**The Magic School Bus: Asteroids & Meteors**

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